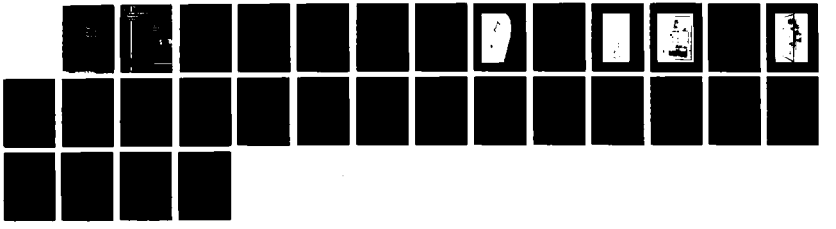
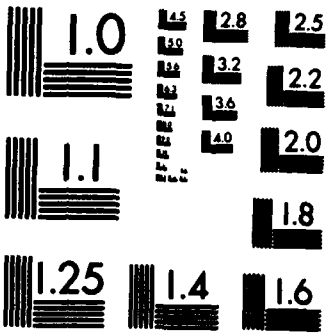
AD-A181 702 ANTENNA CONTROLLER FOR THE 12-14 GHZ SATCOM MOBILE GROUND TERMINAL(U) COMMUNICATIONS RESEARCH CENTRE OTTAWA (ONTARIO) P J VIGNERON FEB 87 CRC-1419 1/1

UNCLASSIFIED F/G 25/5 NL





Communications Research Centre

ANTENNA CONTROLLER FOR THE 12-14 GHz SATCOM MOBILE GROUND TERMINAL

by

P.J. Vigneron

CAUTION

The use of this information is permitted subject to recognition of proprietary and patent rights.

CRC REPORT NO. 1419
OTTAWA, FEBRUARY 1987

Government of Canada
Department of Communications

Gouvernement du Canada
Ministère des Communications

Canada

COMMUNICATIONS RESEARCH CENTRE

DEPARTMENT OF COMMUNICATIONS
CANADA

ANTENNA CONTROLLER FOR THE 12-14 GHz SATCOM MOBILE GROUND TERMINAL

by

P.J. Vigneron

(Space Technology and Applications Branch)

CRC REPORT NO. 1419

February 1987
OTTAWA

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ANTENNA CONTROLLER FOR THE 12-14 GHz SATCOM MOBILE GROUND TERMINAL

by

P.J. Vigneron

ABSTRACT

The design of an antenna controller for use with a mobile 12/14 GHz terminal is discussed. The controller allows variable antenna positioning to an accuracy of .001 degrees. Digital position indicators with provision to preset an angle bias facilitates initial satellite terminal set up at various locations in Canada.

1. Introduction

1.1 General Information

The Antenna Controller is used to control the movement of the 1.8 m dish on the 12-14 GHz Mobile Satellite Ground Terminal (SGT) by front panel open loop command. The displays on the front panel, once calibrated, show the direction in azimuth and elevation that the antenna is pointing in degrees.

1.2 Initial SGT Set Up

The SGT is used with the Anik series of geostationary satellites. For the SGT is to be operated from a desired site, the position of the required satellite relative to that site must be located from charts or tables, and expressed in degrees of azimuth and elevation.

The antenna is then aligned to these measurements.

1.3 Location

The Antenna Controller is mounted inside the SGT trailer in the RF room on a relay rack. The motors, the 1.8 m dish, and the gears are mounted outside the trailer on the antenna frame near the front hitch.

1.4 Description

The Antenna Controller is a 3 1/2 x 19 x 14 inch standard rack mountable unit. It consists of a front (relay) panel attached to a rear chassis (Figure 0-1).

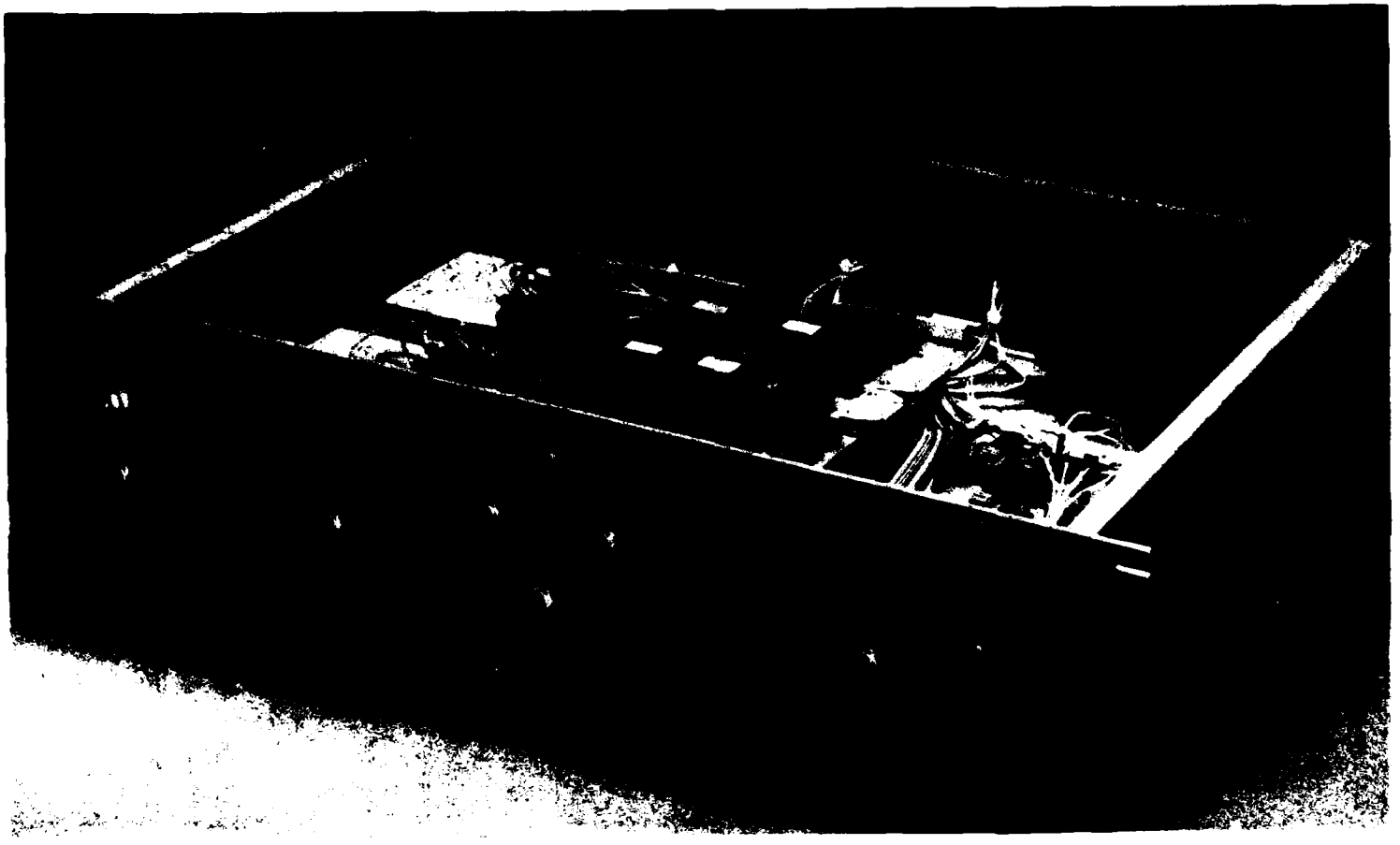


Figure 0-1 Antenna Controller

Figure 1-1 is a photograph of the front control panel.

The rear chassis contains all of the electrical parts, including logic boards, stepper motor drivers, power supply, and display boards. Figure 1-2 is a top view photograph of the rear chassis.

1.5 Specifications

The following are the characteristics of the Antenna Controller.

a) Input Power: logic; 105-132 VAC at 60 Hz nom., 24 Watts max.
Azimuth and elevation motors and drivers; 24 VDC, 6.1 Amps maximum on a 3 pin male Bendix connector.

b) Input Commands: Push-buttons on front panel.

c) Output: Output to the motors are on two 10 pin female Bendix connectors on the rear of unit labelled 'Elevation' and 'Azimuth'.

d) Smallest increment of antenna position: 0.05 degrees.

e) Operating Temperature: Power Supply; 0 to 60 degrees Celsius. Logic; 0 to 70 degrees Celsius.

f) Antenna rotation range: Azimuth; 120 degrees, 60 degrees to each side when the antenna is pointed along the lengthwise axis of the SGT while facing the hitch. Elevation; 75 degrees up from facing the horizontal.

g) Input fuses: Logic; 5 Amps
Motors; 15 Amps

h) Size: Chassis is 17 x 3 inches and 14 inches deep.
Front panel is a 19 x 3 1/2 inch relay panel.

i) Weight: 11 lbs.

j) Finish: Front panel is black with polished wax finish.
Chassis is grey painted steel.

k) Convection cooled, with no fans necessary.

2. Installation

2.1 Mounting

The antenna controller is designed to be mounted in a standard 19" relay rack but may be used in any configuration provided that there is adequate ventilation when in confined areas.

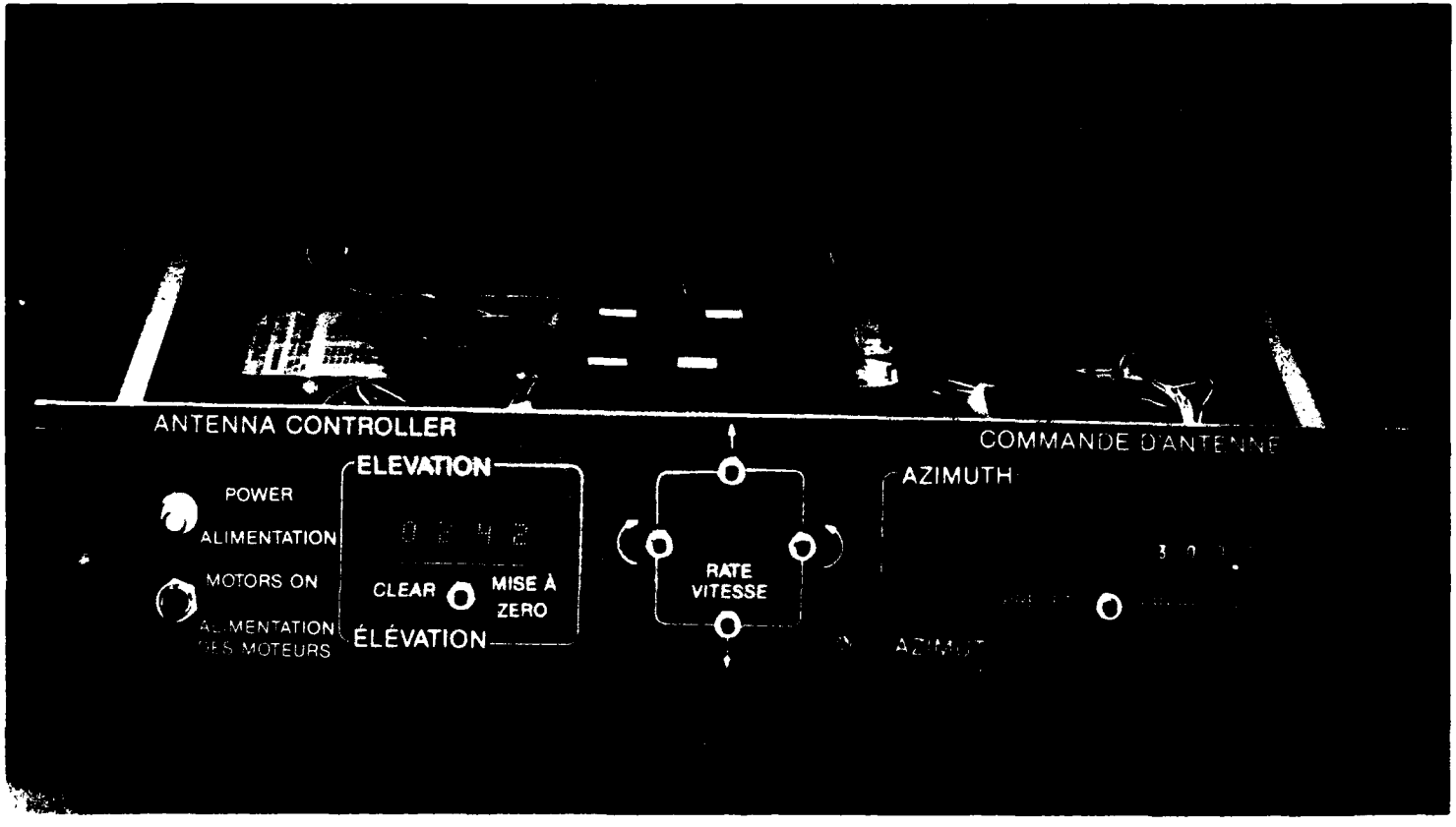


Figure 1-1 Front Panel

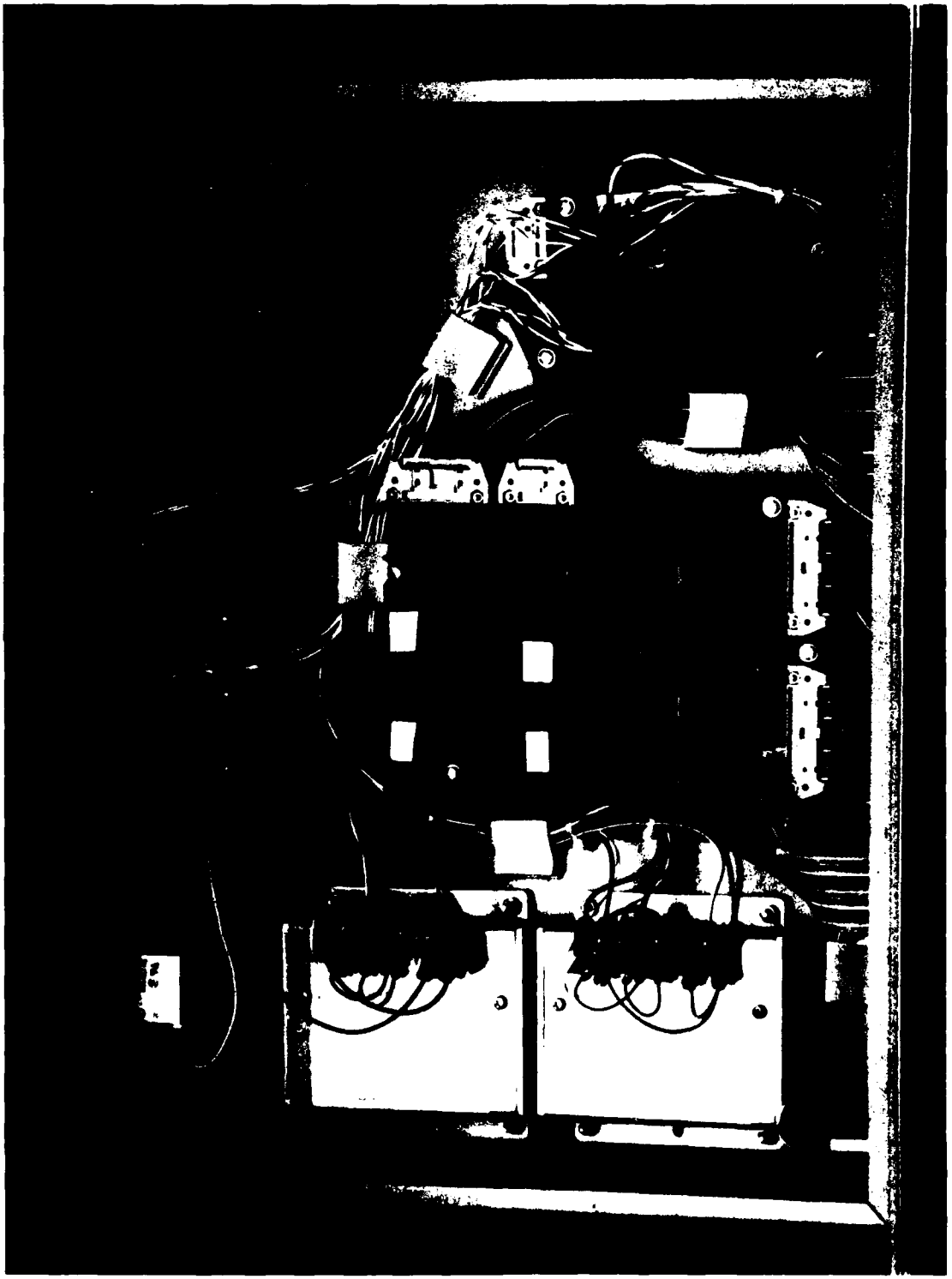


Figure 1-2 Top View of Chassis

If the unit is mounted in a relay rack its weight must not be supported by the front panel as it is heaviest in the rear. Chassis support slides are used for this reason.

2.2 Electrical Connections

The connectors on the rear are as follows:

i) 105-132 VAC at 47-440 Hz, standard AC plug.

ii) 24 VDC, 6.1 Amps max, three pin Bendix.

iii) Elevation connector, 10 pin Bendix.

iv) Azimuth connector, 10 pin Bendix.

Figure 2-1 is a photograph of the connectors on the rear of the unit.

3. Operating Instructions

The three steps in the operation of the Antenna Controller are as follows.

1) Turning On The Panel.

2) Calibrating The Displays.

3) Pointing The Antenna.

3.1 Turning On The Panel

There are two power switches on the front of the Antenna Controller. The display and logic power switch is labelled 'Power/Alimentation'. It is located on the upper left corner of the front panel. The motor power switch is labelled 'Motors On/Alimentation des Moteurs'. It is located on the lower left corner of the front panel.

The display and logic power switch is the main On/Off switch. The Antenna Controller is said to be 'On' when the logic and displays are powered on. When 'On' the red light on the 'Power/Alimentation' switch illuminates.

The 'Motors On/Alimentation des Moteurs' push-button controls the power to the stepper motors. The motors are normally powered off thus the 'Motors On/Alimentation des Moteurs' button must be pressed for movement of the antenna.

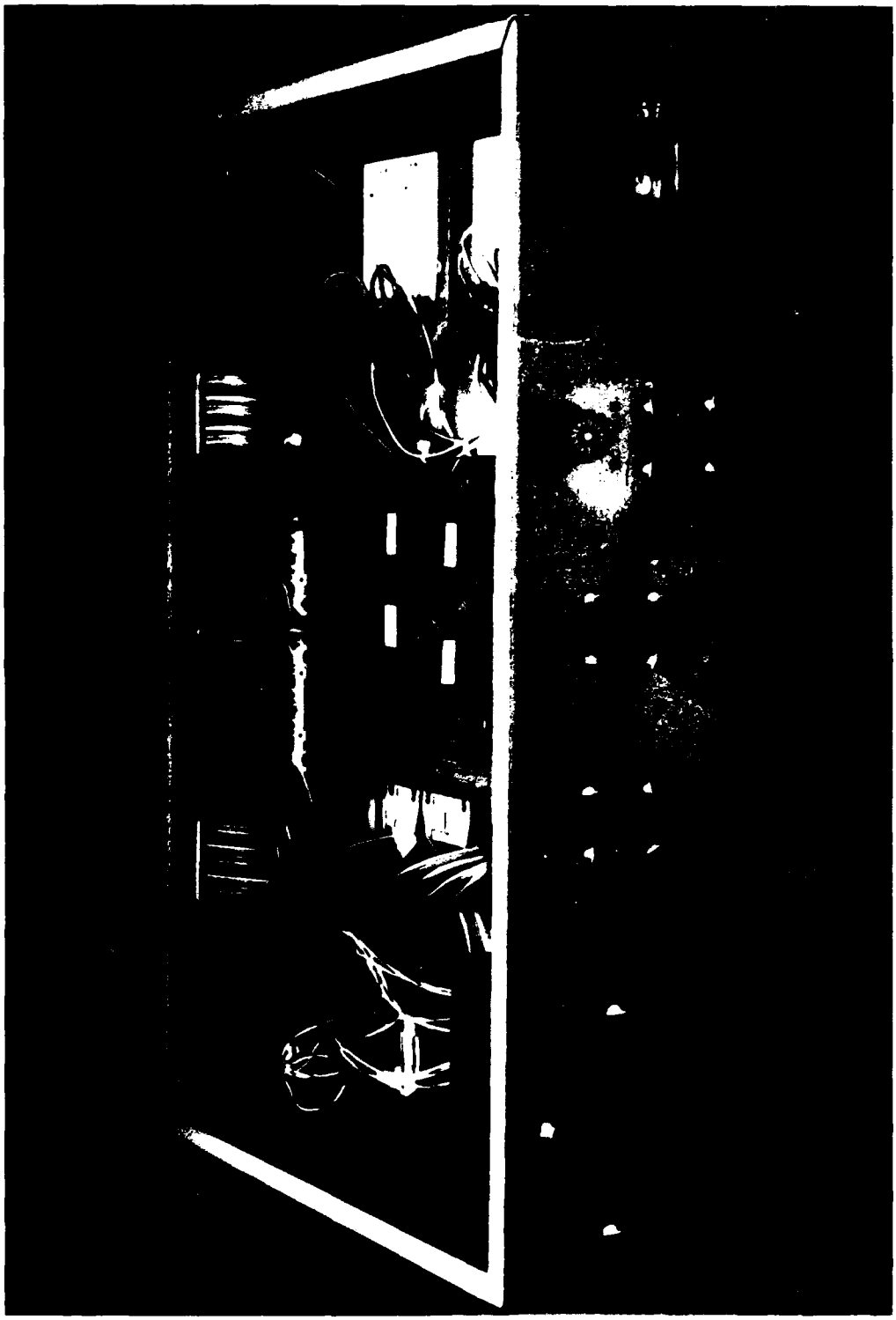


Figure 2-1 Rear View of Chassis

3.2 Calibrating The Displays

The azimuth and elevation displays are in degrees. Before the displays can be of any use, they have to be set to represent the present pointing direction of the antenna.

While the SGT is in transit the antenna must be stowed in the travelling antenna position. The antenna is facing along the central axis of the trailer and rotated back as far as possible (75 degrees) so it is resting on fixed stops.

3.2.1 Elevation Display

Once the SGT is on site, it is levelled using the power jacks and the bubble levels such that the antenna is pointing parallel to the ground. This represents an elevation of zero degrees. The elevation display is zeroed by pressing the push-button labelled 'Clear/Mise a Zero'.

3.2.2 Azimuth Display

The angle that the antenna is facing is found in positive degrees with respect to true North. This is the azimuth angle and it is found using a compass with compensation for magnetic declination. This angle is dialed into the four thumb-wheeled switches in the 'Azimuth' section on the front of the panel. The azimuth display is preset by pressing the push-button labelled 'Preset/Préréglage'.

3.3 Pointing the Antenna

3.3.1 Changing The Direction Of The Antenna

The antenna is moved by pressing a command push-button as well as the 'Motors on/Alimentation des Moteurs' push-button.

The command push-buttons are located near the centre of the front panel. The motion that they induce (from the top button going clockwise) is; Elevation Up, Negative Degrees Azimuth, Elevation Down, Positive Degrees Azimuth.

Fine tuning in the direction of the antenna is accomplished by adjusting the dial labelled 'Rate/Vitesse' to a minimum and moving the antenna in discrete steps, while observing the satellite downlink signal. When the motor power is not on, the displays will not count when the command push buttons are pressed, preserving the calibration of the displays.

3.3.2 Establishing The Proper Direction

Once the displays have been calibrated they show the current absolute direction that the antenna is pointing. When the antenna is moved to another satellite the displays update themselves to reflect the movement.

The antenna is moved until the angles shown on the numerical displays match those that characterize the location of the satellite. A small amount of fine tuning in the direction of the antenna may be necessary.

3.4 Gearing Error

It is important to note that there is some play in the gearing of the motor. There is an error of one degree every time the azimuth direction of rotation changes.

If the required direction of the antenna is overshot and the antenna has to be brought back, the relevant display will be in error by one degree. If two direction changes are made, the errors will cancel each other out.

3.5 Limits

The limits are defined as the extreme range of rotation of the antenna. Section 1.5(g) lists the limits of rotation.

When the antenna is at its limit, switches will cause it to stop rotating in that direction. If the antenna is not able to point towards the satellite within its range, the SGT itself may have to be moved.

If a limit is reached, the antenna can still move in the opposite direction, away from the limit. The display will stay in calibration when the limit is reached.

3.6 Mechanical Cranking

There is back-up mechanical cranking available. Using the mechanical cranks will cause the displays to become out of calibration. The cranks can only be used when the power to the motors is off.

4. Internal Operation Details

The following sections refer to figure 4-1. Figure 4-1 defines the internal components of the Antenna Controller.

4.1 Configuration of Motor Control

The two stepper motors are each driven by a stepper motor driver. The two drivers are capable of moving the motors in the CW and CCW directions. The state and direction of the motors is determined by the Motor Control Board.

When a command is given by the operator to move the antenna in one direction, a pulse is sent down one of the two direction lines from the Motor Control Board to the respective stepper motor driver. The motor direction and driver used are a function of the command push-button that was pressed.

If two command push-buttons are pressed at the same time for one motor to move in opposite directions then both motors will not move at all.

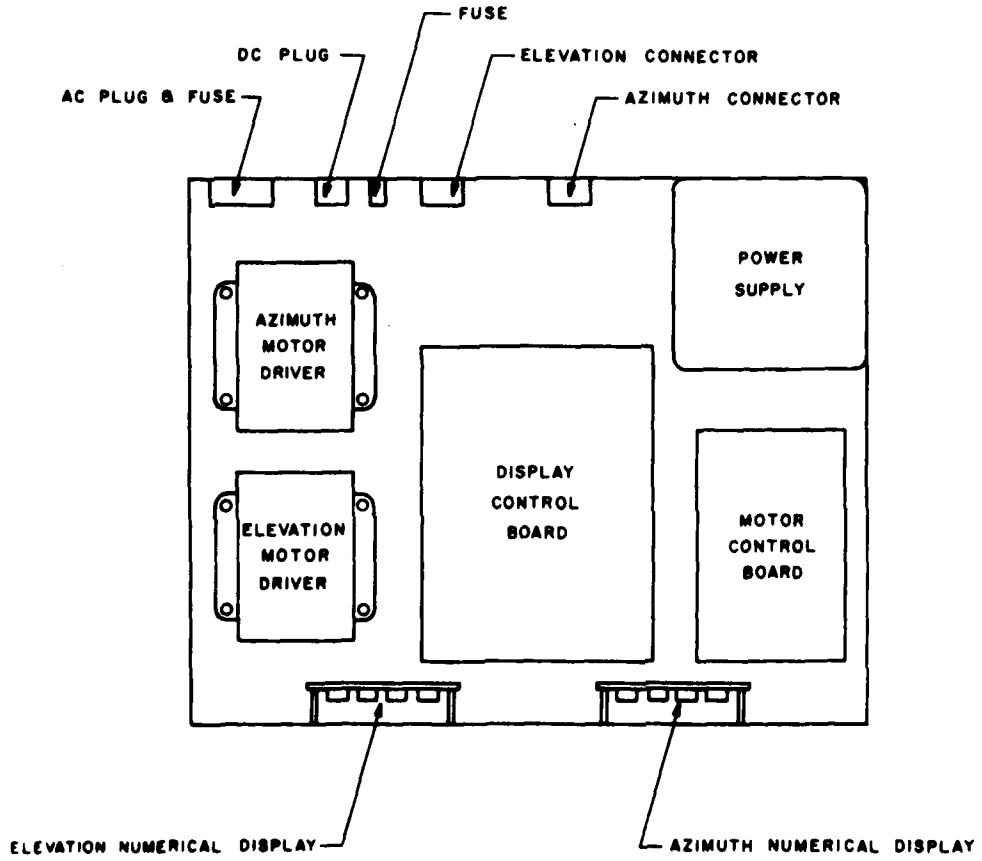


Figure 4-1 Naming of Internal Components

4.2 Antenna Rotation

The torque produced by the motors is mechanically geared down before being applied to the antenna. Each pulse that the stepper motor driver receives causes the motor to rotate one step (1.8 degrees). The gearing factor of 36:1 causes the rotation of the antenna to be 0.05 degrees per pulse. This applies for the motors in both the elevation and the azimuth directions.

4.3 Configuration of Display Control

Each numerical display is driven by a series of four TTL decade counters. The counters and supporting logic are located on the Display Control Board. They maintain the net number of pulses that the Motor Control Board has sent to the stepper motor drivers.

The numerical displays show the antenna position in degrees. The degrees are calculated by multiplying the number of pulses by the gearing factor of 0.05 degrees per pulse.

4.4 Internal Connections

The two logic boards are connected with a number of other internal components of the Antenna Controller. Figure 4-2 is a general diagram of the the two logic boards with their connector names. Figure 4-2-1 is a top view of the Motor Control Board. Figure 4-2-2 is a top view of the Display Control Board. Connector names are characterized by 'En' where 'n' is the connector number. Connections between internal units other than the logic boards are also given.

Figure 4-3 is an interconnect diagram showing the connection between the push-buttons, switches and circuits.

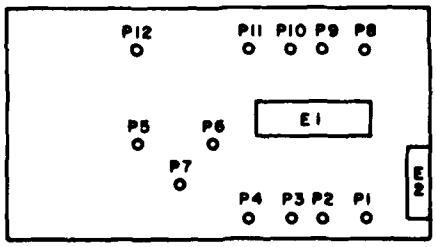
4.4.1 Motor Support Connections

Figure 4-4 shows the complete connections for the stepper motor drivers and the rear elevation and azimuth connectors. Refer to section 7 for an explanation of the pin and connector names used in figure 4-4.

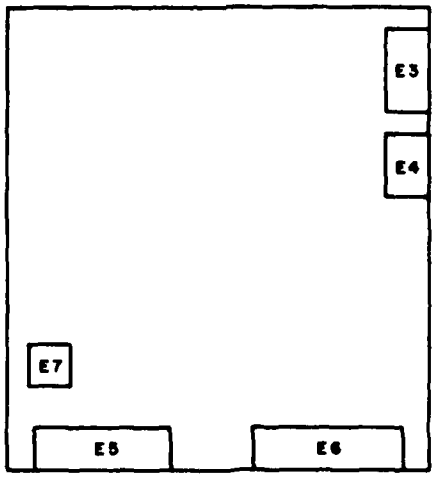
Connector E1 on the Motor Control Board is joined with the Elevation and Azimuth Motor Drivers. These connections are also shown in figure 4-4.

The DC plug is connected with the Elevation and Azimuth connectors via the push-button labelled 'Motors On/Alimentation des Moteurs'.

Pin P1 on the Motor Control Board is connected to the push-button labelled with a clockwise arrow. Pin P2 is connected to the push-button labelled with a counter-clockwise arrow. Pins P3 and P4 are connected to the push-buttons labelled with up and down arrows, respectively. Pins P5, P6, and P7 are connected with the potentiometer labelled 'Rate/Vitesse'. The pin P5 is connected to one of the fixed ends of the Pot. Pins P6 and P7



4-2-1 Motor Control Board



4-2-2 Display Control Board

Figure 4-2 Pin and Connector Names

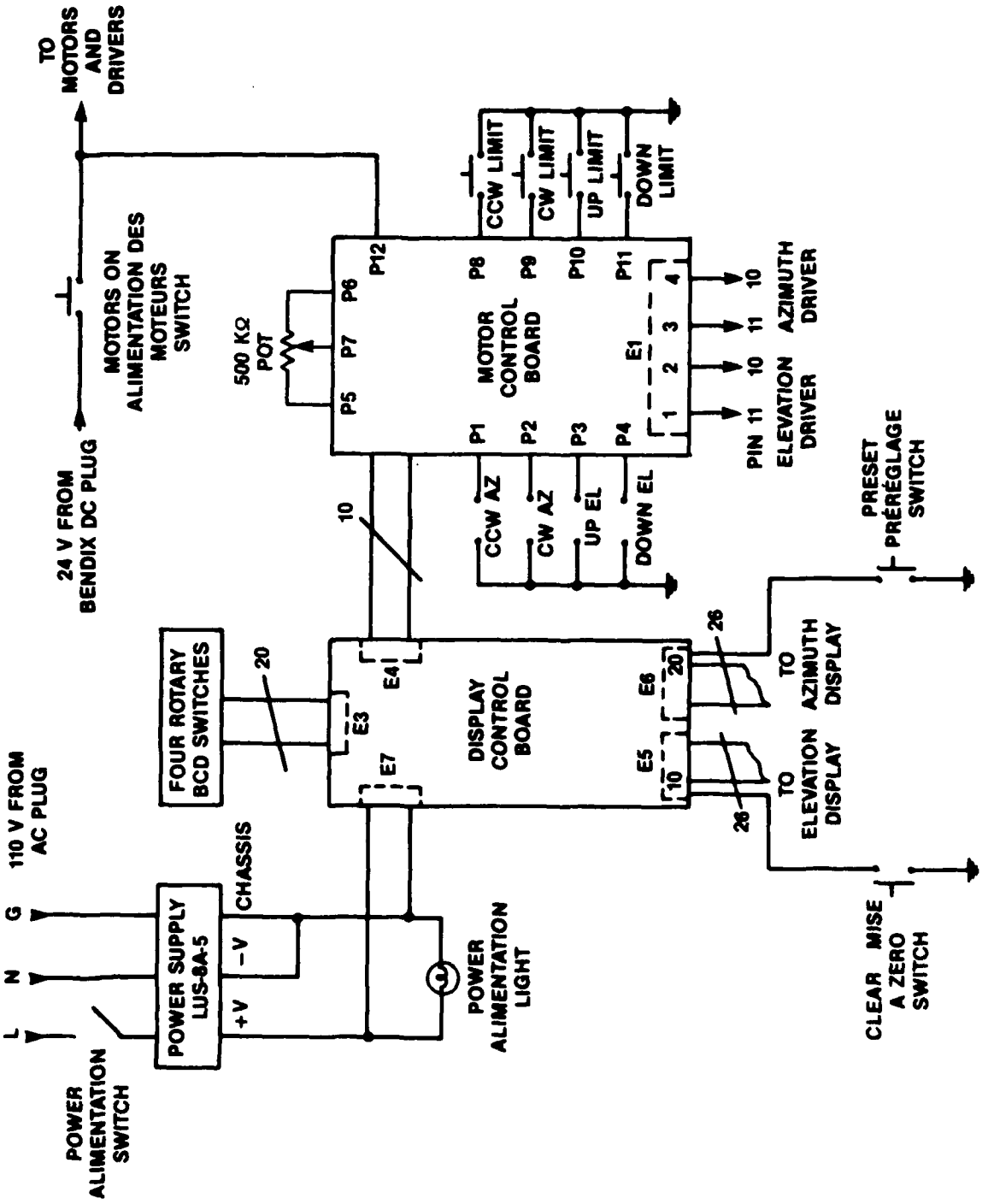


Figure 4-3 Interconnect Diagram

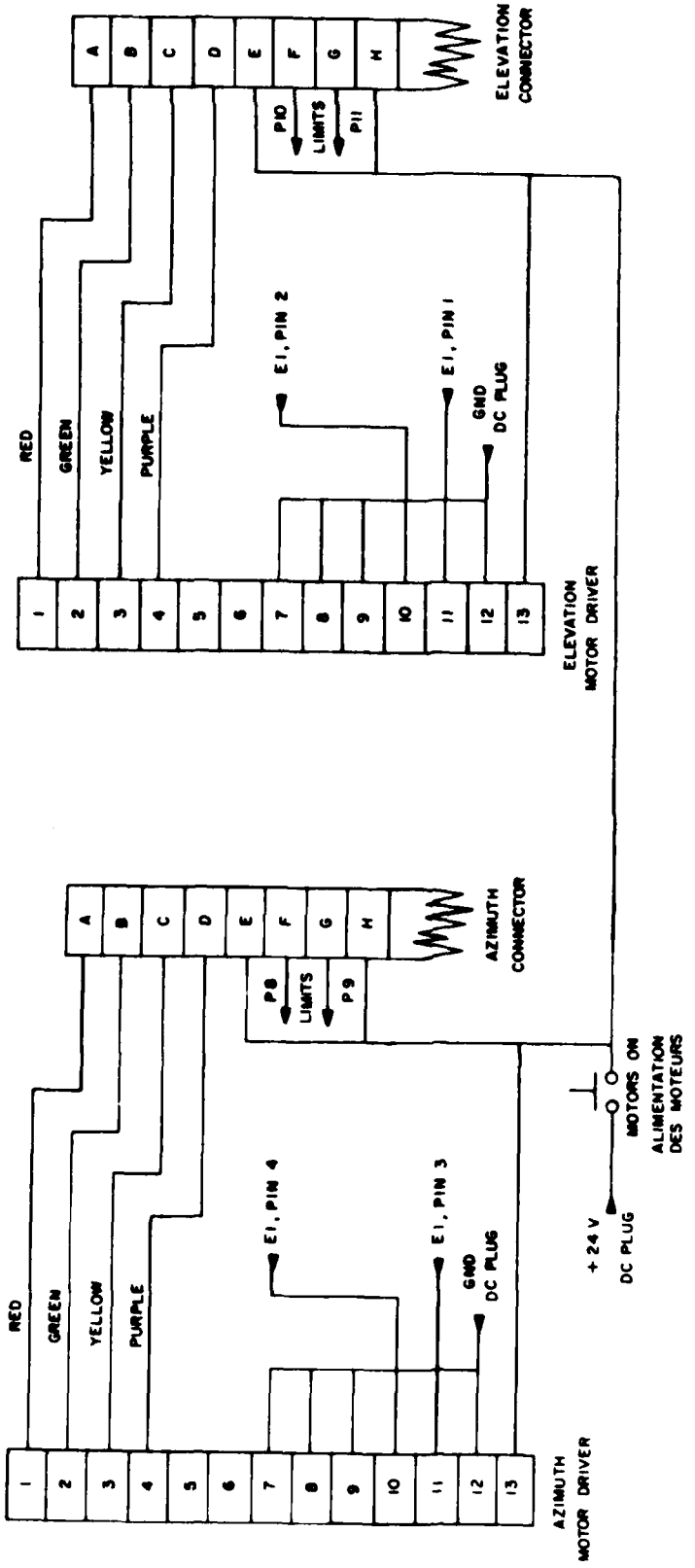


Figure 4-4 Wiring of Motor Devices and Rear Connectors

are connected to the other fixed end and the variable end of the Pot. Pins P6 and P7 are tied together within the circuit.

Pins 8, 9, 10 and 11 are the limit connections for Pins 1, 2, 3 and 4 respectively. Pin P12 is connected to the 24 VDC line after it goes through the 10 Amp push-button.

4.4.2 Display Support Connections

The AC plug is connected to the power supply via the push-button labelled 'Power/Alimentation'.

The +5V output of the power supply is joined with the connector E7 on the Display Control Board.

Connector E2 on the Motor Control Board is joined with the connector E4 on the Display Control Board (see figure 4-2).

The four rotary switches are joined with the connector E3 on the Display Control Board.

Connectors E5 and E6 are joined with the Elevation and Azimuth numerical displays, respectively.

5. Maintenance

In the event of failure of the Antenna Controller, the following factors should be considered.

5.1 Fuses

The fuse should be checked. If a fuse has blown then the system that contained the fuse should be checked for shorts, ie. if the display and logic fuse blew then the display and logic system should be checked for shorts. The power supply has a built in current limiting circuit which will limit the short circuit output current to a safe level. There is also a fuse on the AC line inside the power supply.

5.2 Circuit Boards

If it is apparent that there is something wrong with one of the boards there are spares provided for each of the two logic boards. Schematic diagrams for the two boards are provided in Section 7. Descriptions of the connections are provided in section 4.4.

5.3 Temperature

It is necessary that the operating temperature be within the acceptable range. If this is not the case then better ventilation must be

provided. If the temperature range is exceeded then permanent damage may be caused to the integrated circuits or the power supply.

5.4 Power Supply

The output of the internal logic power supply lies within the range of 4.8 to 5.2 Volts. The DC output of the supply is regulated to within this range. Permanent damage to the integrated circuits will be caused by voltages exceeding 5.25 Volts.

5.5 General

The unit should be checked for loose connections, frayed or loose wires, and loose screws. The connectors as well as the electrical components should be checked. The limit switches should be checked for shorts and being jammed closed.

6. Parts List

Following is a list of parts used in the Antenna Controller. Included are major parts only. Parts such as screws, sockets, or wires are not included.

6.1 Front Panel and Chassis

Designation/Function	Qty.	Manufacturer	Part No.
Chassis, 14x17x3 inches	1	Hammond	1441-38
Relay Panel, 19x3 1/2 inches	1	Hammond	PBPA-19-003-GY2
Front Panel, Photoplated	1	CRC	
Stepper Motor Controller	2	Rapidsyn	DMA-64
Power Supply, 5 Volts	1	Lambda	LUS-8A-5
Plug and fuse holder	1	CORCOM	F1881
Fuse socket	1	Littelfuse	342-22
BCD Rotary Switch Hardware	4	Cherry	T56-04M
5 Amp Push-button switch	1	IPI	616
10 Amp Push-button switch	1	Gray Hill	2201
Power socket	1	Bendix	12-3 (Male)
Fuse, 5A, 15A	2	Liffelfuse	
SH-buttons, 1A	6	Grayhill	30-1
26 Pin Connector	2	3M	3429
7-Segment Display	8	Texas Instruments	TIL-311
10 Pin connector	2	Bendix	12-10 (Female)

6.2 Motor Control Board

Designation/Function	Qty.	Manufacturer	Part No.
3x5 inch vectorboard	1	Vector Board	
2 input AND gate	2	National Semi-conductor	7408
Hex contact Bounce Eliminator	1	Motorola	MC14490
Inverter	1	Fairchild	74LS04
Timer	1	Signetics	NE555
3 input Nand	1	Signetics	74LS10
5.6 KΩ Resistor	4	Allen Bradley	
820 KΩ Resistor	1	Allen Bradley	
10 KΩ Resistor	1	Allen Bradley	
1 KΩ Resistor	8	Allen Bradley	
.01 μf capacitor	2	Erie	
4.7 μf electrolytic capacitor	1	Spragve	
1000 pf capacitor	1	Erie	
.1 μf capacitor	2	Erie	
10 pin connector (E2)	1	3M	3446
500 Ω potentiometer	1	Ohmite	ASM6663
16 pin component carrier (E1)	1	Cambion	ASM6663

6.3 Display Control Board

Designation/Function	Qty.	Manufacturer	Part No.
7x5 inch vectorboard	1	Vector Board	
128 K U.V. EPROM	2	INTEL	27128
16 K U.V. EPROM	2	INTEL	2716
DECADE counter	8	Fairchild	74LS192
4 bit binary full adder	6	Fairchild	74283
2 input Nand gate	1	Motorola	74LS03
3 input NOR gate	2	Fairchild	74LS27
Schmitt trigger inverter	1	National Semi-conductor	7414
2 input NAND	1	Motorola	74LS00
8 input NAND	2	Fairchild	74LS30
Inverter	1	Fairchild	74LS04
2 input AND	1	Motorola	74LS08
1 KΩ DIP Resistor (10 pin)	2		83243
1 KΩ Resistor	2	Allen Bradley	
500 Ω Resistor	1	Allen Bradley	
10 μf electrolytic capacitor	1	Spragve	
.01 μf decoupling capacitor	7	Erie	
1 μf decoupling capacitor	8	Erie	
20 pin connector (E3)	1	3M	3428
10 pin connector (E4)	1	3M	3446
26 pin connector (E5)	1	3M	3429
26 pin connector (E6)	1	3M	3429

6.4 External to the Unit

Designation/Function	Qty.	Manufacturer	Part No.
Stepper Motor	2	RAPIDSYN	42D-112-12AR
10 pin connector	2	Bendix	12-10 (male)
3 pin connector	1	Bendix	12-3 (female)
3.5 ohm resistor	4	Ohmite	

7. Schematic Diagrams

The connector names used in the schematic diagrams are E1,E2,...E7. When a wire is brought to a connector the pin number and connector name are given. An exmple is 'Pin 4 E1'.

There are also individual pins on the Motor Control Board. The pin names used are P1,P2,...P7. When a wire is brought to an individual pin the pin name is given only. An example is 'P1'. There are no individual pins on the Display Control Board.

The connectors are named in figure 4-2.

Figure 7-1-1 is a diagram of the pin-out for a 26 pin connector. The same pattern of pin numbering is used for the 10 and 20 pin connectors. Pin 1 on the connector is characterized by a triangle above it on the connector casing. The connectors E2,E3,E4,E5, and E6 follow this pattern.

Figure 7-1-2 is the pin-out for the connector E1.

Figure 7-1-3 is the pin-out for the connector E7.

The schematic drawings are as follows.

Figure 7-2 Motor Control Board Circuit-CRC Drawing ########.

Figure 7-3 Display Control Board Circuit-CRC Drawing ########.

8. Conclusion

The Antenna Controller is an integral tool for use in the deployment of the SGT. It enables the operators to establish a communications link with the satellite in a straight forward manner.

9. Acknowledgments

The author wishes to acknowledge the guidance of Mr. A.H. McEwen in this project.

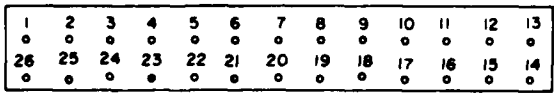


Figure 7-1-1

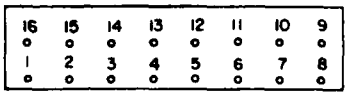


Figure 7-1-2

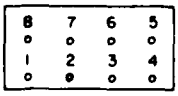


Figure 7-1-3

Figure 7-1 Numbering conventions for connectors

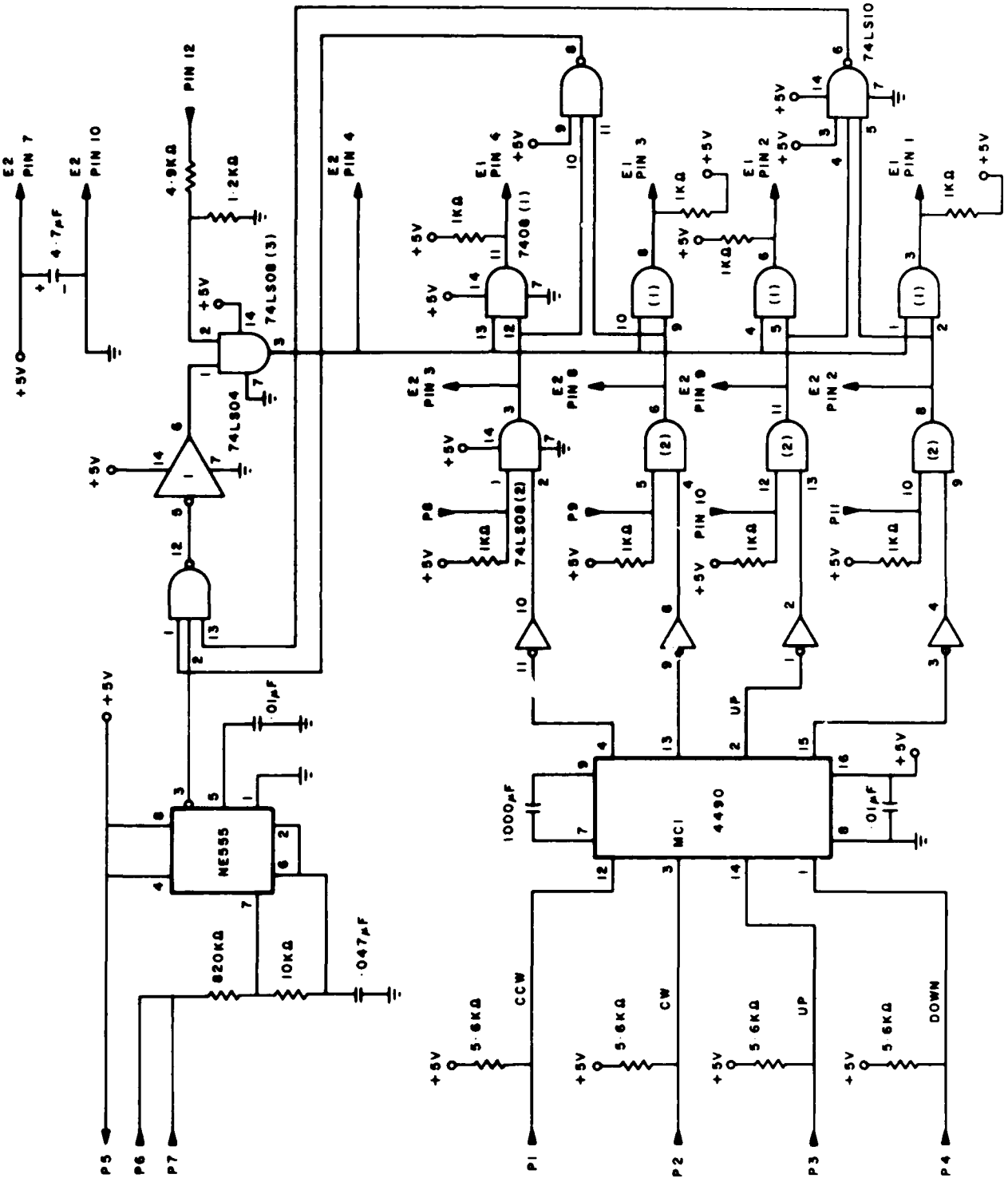


Figure 7-2 Schematic Diagram of Motor Control Board

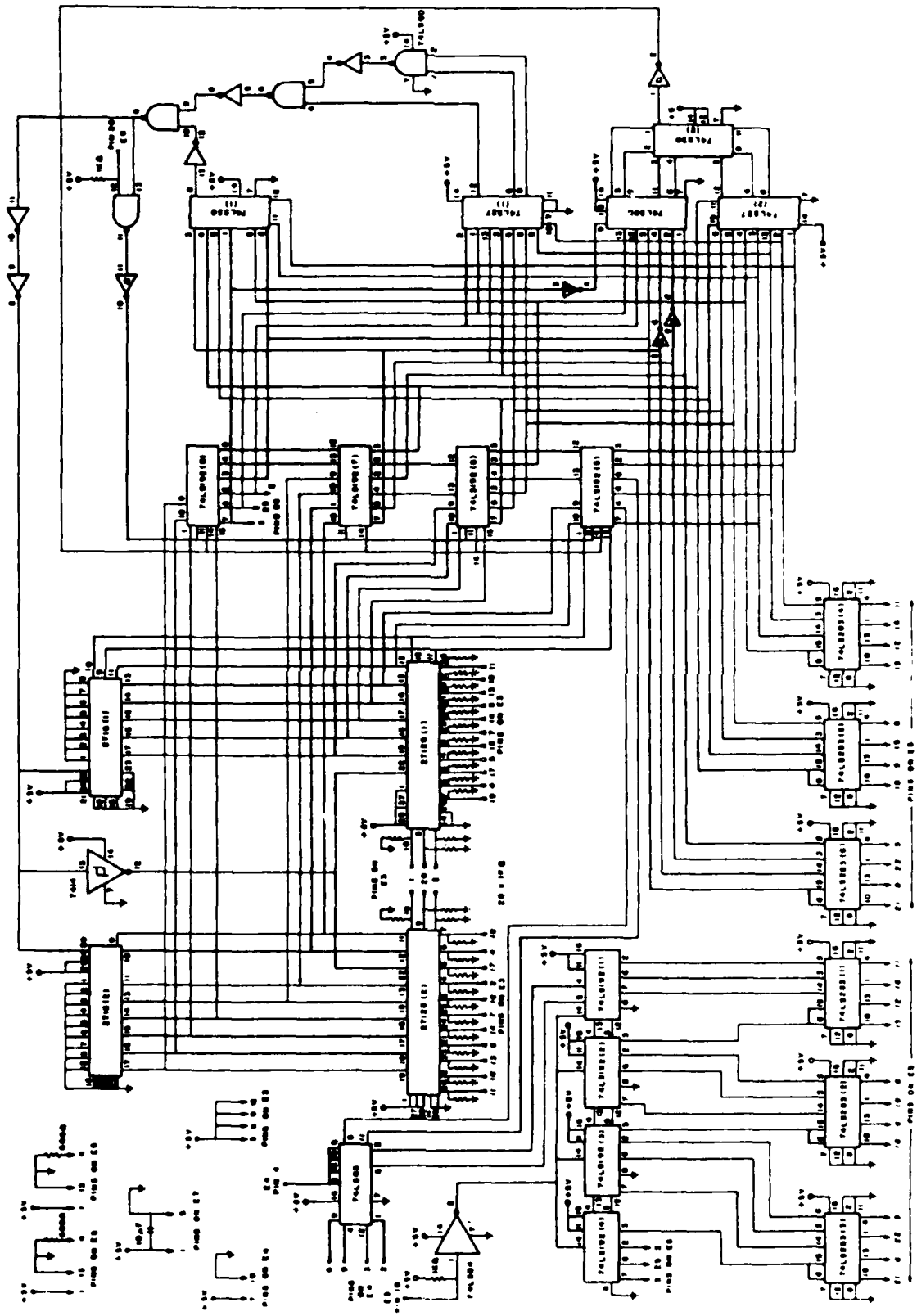


Figure 7-3 Schematic Diagram of Display Control Board

10. References

1. R. Brun del Re, "Design, Fabrication and Test of an EHF Steerable Beam Antenna System", CRC Technical Memorandum SS #6.

UNCLASSIFIED
Security Classification

DOCUMENT CONTROL DATA - R & D
(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1 ORIGINATING ACTIVITY Communications Research Centre P.O. Box 11490, Station H Ottawa, Ontario K2H 8S2	2a. DOCUMENT SECURITY CLASSIFICATION UNCLASSIFIED 2b GROUP
3 DOCUMENT TITLE Antenna Controller for the 12-14 GHz Satcom Mobile Ground Terminal	
4 DESCRIPTIVE NOTES (Type of report and inclusive dates) CRC Report	
5 AUTHOR(S) (Last name, first name, middle initial) Vigneron, P.J.	
6 DOCUMENT DATE February 1987	7a TOTAL NO OF PAGES 26 / 7b. NO. OF REFS 1
8a. PROJECT OR GRANT NO Defence R&D program-task ID Code 14100415W	9a ORIGINATOR'S DOCUMENT NUMBER(S) CRC RPT 1419
8b CONTRACT NO	9b OTHER DOCUMENT NO (S) (Any other numbers that may be assigned this document)
10 DISTRIBUTION STATEMENT Unlimited distribution.	
11 SUPPLEMENTARY NOTES	12. SPONSORING ACTIVITY Defence Research Establishment Ottawa

13 ABSTRACT

The design of an antenna controller for use with a mobile 12/14 GHz terminal is discussed. The controller allows variable antenna positioning to an accuracy of .001 degrees. Digital position indicators with provision to preset an angle bias facilitates initial satellite terminal set up at various locations in Canada.

DSIS

Security Classification

KEY WORDS

Antenna Controller

SATCOM

Terminal

INSTRUCTIONS

1 ORIGINATING ACTIVITY: Enter the name and address of the organization issuing the document.

2a DOCUMENT SECURITY CLASSIFICATION: Enter the overall security classification of the document including special warning terms whenever applicable.

2b GROUP: Enter security reclassification group number. The three groups are defined in Appendix 'M' of the DR8 Security Regulations.

3. DOCUMENT TITLE: Enter the complete document title in all capital letters. Titles in all cases should be unclassified. If a sufficiently descriptive title cannot be selected without classification, show title classification with the usual one-capital-letter abbreviation in parentheses immediately following the title.

4 DESCRIPTIVE NOTES: Enter the category of document, e.g. technical report, technical note or technical letter. If appropriate, enter the type of document, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the document. Enter last name, first name, middle initial. If military, show rank. The name of the principal author is an absolute minimum requirement.

6. DOCUMENT DATE: Enter the date (month, year) of Establishment approval for publication of the document.

7a TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the document.

8a. PROJECT OR GRANT NUMBER: If appropriate, enter the applicable research and development project or grant number under which the document was written.

8b. CONTRACT NUMBER: If appropriate, enter the applicable number under which the document was written.

9a. ORIGINATOR'S DOCUMENT NUMBER(S): Enter the official document number by which the document will be identified and controlled by the originating activity. This number must be unique to this document.

9b. OTHER DOCUMENT NUMBER(S): If the document has been assigned any other document numbers (either by the originator or by the sponsor), also enter this number(s).

10. DISTRIBUTION STATEMENT: Enter any limitations on further dissemination of the document, other than those imposed by security classification, using standard statements such as

(1) "Qualified requesters may obtain copies of this document from their defence documentation center."

(2) "Announcement and dissemination of this document is not authorized without prior approval from originating activity."

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document, even though it may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall end with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (TS), (S), (C), (R), or (U).

The length of the abstract should be limited to 20 single-spaced standard typewritten lines 7½ inches long.

14 KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a document and could be helpful in cataloging the document. Key words should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context.

END

7-87

DTIC